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PROCEEDINGS 1900

KANSAS GAS, WATER
AND ELECTRIC LIGHT
ASSOCIATION.

PROCEEDINGS
OF THE
KANSAS GAS, WATER
AND
ELECTRIC LIGHT
ASSOCIATION.

THIRD ANNUAL MEETING

HELD AT

LAWRENCE, KANSAS, DECEMBER 12-13.

1900.

PUBLISHED BY THE ASSOCIATION.

EDITED BY THE SECRETARY.

DAKOTA
ROSE KC

MEMBERS ON THE STEPS OF THE UNIVERSITY BUILDING, LAWRENCE.

P R O C E E D I N G S
 OF THE
 T H I R D A N N U A L M E E T I N G
 OF THE
 KANSAS GAS, WATER AND ELECTRIC LIGHT ASSOCIA-
 TION. HELD AT LAWRENCE, KANSAS,
 DECEMBER 12 AND 13, 1900.

First Day—Morning Session.

Meeting was to have been called at 10 o'clock a m., but on account of delayed trains, was not called until 2 o'clock p. m., by the president, Mr. Northrop Moore. The following members were in attendance:

HONORARY MEMBERS.

Bailey, Prof. E. H.,	.	.	Lawrence.
Blake, Prof. Lucien I.,	.	.	Lawrence.
Marvin, Prof. F. O.	.	.	Lawrence,

ACTIVE MEMBERS.

Bendure, J. W.,	.	.	Atchison.
Foley, J. H.,	.	.	Leavenworth.
Frost, W. H.,	.	.	Ft. Scott.
Johnston, R. C.,	.	.	Lawrence.
Moore, Northrop,	.	.	Kansas City.
Morgan, H. S.,	.	.	Topeka.
Morse, J. C. O.,	.	.	Hutchinson.
Nicholson, Jno. C.,	.	.	Newton.
Palmer, L. T.,	.	.	Leavenworth.
Rodgers, A. T.,	.	.	Beloit.
Seabury, W. G.,	.	.	Pittsburg.
Shaw, Jesse,	.	.	Topeka.
Sterrett, Samuel W.,	.	.	Kansas City.
Tracy, Wm.,	.	.	Salina.
Wills, E. S.,	.	.	Atchison.

ASSOCIATE MEMBERS.

Ambler, T. M.,	St. Louis, Mo.
Gregg, W. S.,	Kansas City, Mo.
Riddle, L. E.,	Kansas City, Mo.
Seymour, H. G.,	Kansas City, Mo.

THE PRESIDENT:—Unless desired by some member of the Association, the reading of the minutes of the last meeting will be dispensed with.

There was no request made.

The Executive Committee reports the following applications for membership, and recommends that they receive favorable action:

PROPOSED FOR ACTIVE MEMBERSHIP.

Cady, Atwood, Fredonia, Kans., president of the Fredonia Water Company.
 Fountain, Wm. H., Eldorado, Kans., superintendent of the Eldorado Water Company.
 McKim, James, Weir City, Kans., superintendent of the Weir City Light and Water Plant.
 Patmor, James, Pittsburg, Kans., manager of the Pittsburg Gas and Electric Light Company.
 Soden, W. T., Emporia, Kans., president of the Emporia Gas Company.

PROPOSED FOR ASSOCIATE MEMBERSHIP.

Reed, E. M., Kansas City, Mo., of E. M. Reed & Company, electrical supplies.
 Schaefer, J. F., Kansas City, Mo., agent for the General Electric Company, Chicago, Ill.
 Sherman, C. K., Kansas City, Mo., Manufacturers' Agent.
 Wakefield, R. S., Chicago, Ill., agent for the Central Electric Company.

THE PRESIDENT:—You have heard the report of the Executive Committee upon applications for membership; what is your pleasure?

MR. FROST:—I move that the Secretary cast the ballot of the Association for the election of those whose names have been read.

The President, on putting the motion, announced that a single objection would rule it out of order.

Carried.

THE PRESIDENT:—I will appoint Mr. Nicholson and Mr. Shaw to count the vote.

MR. SHAW:—I have the pleasure of announcing that the unanimous vote of the Association has been cast for the candidates for membership whose names have been read by the Secretary.

THE PRESIDENT:—Gentlemen, you have just been elected members of this Association. We heartily welcome you, and hope that you will at once commence to take part in our meetings.

THE PRESIDENT:—We will next have the report of the Treasurer.

The Secretary read the following:

Report of the Treasurer for the year ending December 10th, 1900.

RECEIPTS.

Initiation fees, members elected Nov. 16, '99.....	\$11 00	
Initiation fees, members to be elected December 12, 1900.....	3 00	
Dues for 1900.....	46 00	
Dues for 1901.....	6 00	
	<hr/>	
Total Receipts.....	\$66 00	
Cash balance Nov. 14, 1899.....	27 75	\$93 75
	<hr/>	

EXPENDITURES.

Express charges on records.....	\$ 0 40	
W. T. Maunder & Co., for suit case.....	9 75	
F. P. Burnap, printing and stationery...	5 00	
Cozad Printing Co.....	4 50	
Postage stamps.....	4 50	
	<hr/>	
	24 15	
Cash Balance December 10, 1900....	69 60	\$93 75

Respectfully submitted by

SAMUEL W. STERRETT, Treasurer.

To the President and Members of the Kansas Gas, Water and Electric Light Association:

GENTLEMEN:—The undersigned members of the Executive Committee have duly examined the books, accounts and vouchers of the Treasurer of this Association for the year ending December 10th, 1900, and have found the same to be correct.

Signed: R. C. JOHNSTON,
NORTHROP MOORE,
L. T. PALMER.

THE PRESIDENT:—What is your pleasure in reference to the report of the Treasurer and the Executive Committee?

MR. FROST:—I move that the reports be received and placed on the records.

Carried.

The Secretary read the Secretary's report as follows:

Membership report of the Secretary for the year ending September 30, 1899:

HONORARY MEMBERS.

On roll October 1, 1899	2	
Elected November 15, 1899	1	
	<hr/>	
On roll September 30, 1900		3

ACTIVE MEMBERS.

On roll October 1, 1899	28	
Elected November 15, 1899	5	
	<hr/>	
	33	
Resigned during year	3	
	<hr/>	
On roll September 30, 1900		30

ASSOCIATE MEMBERS.

On roll October 1, 1899	0	
Elected November 15, 1899	6	
	<hr/>	
On roll September 30, 1900		6
	<hr/>	
Total membership September 30, 1900		39

RESIGNED.

Geo. B. Wing, Kansas City, Kans; A. H. Purdy, Topeka, Kans.; J. N. Hodges, Pittsburg, Kans.

Respectfully submitted,
SAMUEL W. STERRETT, Secretary.

MR. FOLEY:—I move that this report be received and placed on record.

Carried.

THE PRESIDENT:—Is the Committee on Nominations ready to report?

Mr. Johnston read the following report:

Kansas Gas, Water and Electric Light Association:

GENTLEMEN:—Your Nominating Committee reports the following nominations:

President—A. T. Rodgers, Beloit.

First Vice-President—F. D. Aley, Wichita.

Second Vice-President—W. G. Seabury, Pittsburg.

Third Vice-President—W. H. Frost, Fort Scott.

Secretary and Treasurer—Samuel W. Sterrett, Kansas City.

Executive Committee—Jesse Shaw, Topeka; Northrop Moore, Kansas City; C. R. Maunsell, Topeka.

Respectfully submitted,
R. C. JOHNSTON, Chairman.

THE PRESIDENT:—You have heard the report of the Nominating Committee. There being no objections, I will cast the vote.

Carried.

The president then read the following address:

PRESIDENT'S ADDRESS.

GENTLEMEN:—It is a great pleasure for all of us to meet again at our third annual session. It is especially gratifying to know that we have lost none of our members by death.

Our former secretary, Mr. J. H. Foley, is returned to us in health and we give him a hearty welcome.

The past year has brought increased business to us all because our patrons have increased in numbers and their income has been greater. The latter fact enables them to use gas, water and electricity more freely.

We have all been subjected to increased prices for all materials used in our business without being able to collect the increased prices from our consumers as other merchants and manufacturers do.

Many of us have postponed all construction work because of unreasonable prices of materials during the year. Cities desiring to purchase plants at reasonable values will appreciate this in the future, though they fail to consider the point at the present time.

The call for extensions in a growing city is a subject which causes all of us much anxiety. Many companies have proper limitations in their ordinances by which extensions are ordered only as the business offered is sufficient to pay a reasonable profit. This is certainly the proper way. Others are obliged to make extensions when ordered without regard to unreasonable prices of material or the amount of business to be secured.

When interest, leakage and taxes are charged to unprofitable extensions it becomes so serious a matter that the stability of the company is involved. The payments of dividends to the stockholders is no longer made and the far distant future furnishes the only hope of returns.

We should urge our municipal authorities to go slow in reducing rates.

The best service must always be given and the rate should permit this. If we are expected to get unprofitable business by extensions urged on account of paving and other special reasons, our rates should permit us to do this.

The natural growth of cities is no longer observed and this makes it very difficult to supply the demand for our products.

Real estate speculation develops the limits of our

cities and the electric railways encourage this plan, because people living there must ride. Instead of taking the poor people from congested districts to these limits, the result has been to take the well-to-do class, who wish all the comforts of the city.

While in theory all people who contribute to the support of a city by paying taxes for light and water, are entitled to have them, in practice no private or public company is able to supply the demand.

Our proper argument is, that their location was not made by compulsion and they must wait for the natural growth of the city.

Where houses are in demand the privilege of using light and water adds increased value to the property.

In our city, sixty dollars per annum increased rent is given. This capitalized at 6% means one thousand dollars. The reason for the persistent demand for our product by residents of outlying districts is thus very apparent.

Taxes must either be paid out of capital or by the consumer.

No company can long continue in business which does not follow the latter method. If we pay no taxes, we are then able to give this advantage to the consumer by lowering of rates.

Public sentiment demands that we pay taxes in the regular way. Our business differs greatly from others. We have large capital invested in proportion to our business. It takes years for the amount of our business to equal the amount of capital. Merchants and manufacturers have small capital and do a large volume of business. The cost of taxes per unit of our product is therefore very large, and it is burdensome where we get a low rate for our products.

It has been suggested that after we have an agreed valuation on our plants with our assessors and county commissioners at a certain rate of taxation, which equals

a certain rate per unit of our product, we make our future assessments on this basis.

If we make new extensions the following year, the amount of our product sold should determine the assessment and not the value of the new extensions, which are always in dispute.

There seems to be irregularity in regard to listing property for taxation. A water company lists mains as personal property, gas company as real estate in the same town. A glance at our daily papers shows that legislation, good, bad and indifferent against water, gas and electric light companies will be asked for in the next Kansas Legislature.

It is urged that a commissioner appointed by the Governor should have the control of our business on a plan similar to the Massachusetts Gas and Electric Light Commission. As there are so few light companies in the state, water companies can also be included and one commissioner can do the work of a board, to keep expenses down.

The term of office should be six years or more, so that one could become familiar with the business.

He should require a uniform system of accounts for municipal and private plants, so that exact comparison can be made. His duties should be similar to the Massachusetts Commission which has been fairly satisfactory. Another plan has been suggested and legislative bills introduced in different states to permit municipal control upon a sound basis.

The following is a copy of a bill introduced in the last Ohio Legislature. This plan has more advocates:

A BILL

To Authorize and Regulate Contracts by and between Municipalities and Public Service Corporations.

Be it Enacted by the General Assembly of the State of Ohio:

Section 1. Definitions.—The terms “municipal” and “municipality,” whenever used in this act, shall be

construed to mean and to include all "village and city" corporations. The terms "public service" and "public service industry" shall be construed to mean and to include any service supplied to the municipality, and to private and other users, to be paid for on the basis of the service used by each, the means for supplying which are owned and operated by a public service corporation. The terms "public service corporation" and "corporation" shall be construed to mean and to include any person, copartnership or corporation owning and operating a means for supplying a public service to a municipality and to its inhabitants.

Section 2. Power to Contract.—Every municipality shall have power to secure for its use, or for the use of its inhabitants, a continuous supply of any public service by a contract made in accordance with the provisions of this act, with an existing public service corporation now rendering such service, or with a corporation that may be hereafter incorporated under the laws of this state for the purpose of rendering such service, which contract shall be executed by the mayor and countersigned by the director of law, or other legal adviser of the municipality in conformity with the terms prescribed by ordinance of the municipal council.

Section 3. Public Accounts.—All accounts of a contracting corporation, necessary to the determination of the cost of the service, shall be public accounts from and after the date of its contract, and shall be kept as prescribed by the auditor of the state, which shall be identical in every particular with the system of accounting prescribed by the auditor of state to determine the cost of public services owned and operated by municipalities, and such accounts shall be reported to, and audited by, the auditor of state, in such form and at such times as he may require.

Section 4. Cost of Service.—The cost of the service rendered by a contracting corporation shall be determined by including in a statement of items of cost, interest computed on the full amount of actual investment, at the rate per cent paid by the municipality on its bonded debt; a sufficient provision for losses by acci-

dents of every kind; a provision for municipal, county and state taxes, and for compensations to be paid to the municipality if required; a provision for insurance against impairment of investment by depreciation from use and other causes, and the entire and true cost of all material used, salaries and wages paid and of miscellaneous expenses. The provisions for accidents, taxes and depreciation specified in this section shall be determined in each case by a rate per cent fixed by the auditor of state, to be computed on the full amount of investment.

Section 5. Limitation on Corporation Profits.—The share of profit of a contracting corporation shall be limited to an amount equal to the product of a rate per cent twice the rate per cent paid by the municipality on its bonded debt, computed on the full amount of investment, plus its share of a divisible surplus profit, as provided in Section 9 of this act.

Section 6. Profit-sharing with Employees.—A contracting corporation may adopt a system of profit-sharing with its employees, in which case it shall be entitled to earn and to pay to employees the same rate per cent upon the wages earned by them as it earns on its investment.

Section 7. Compensation to the Municipality.—The municipal council shall fix the compensation that shall be paid to the municipality annually by a contracting corporation, if it is the policy of the municipality to require compensation for the use of its rights of way, during the period for which it fixes the prices a corporation may charge public, private and other users for the service to be rendered by it to them. Such compensation shall be assessed at a fixed rate per cent, to be computed on the entire corporate income for service sold and paid for during the year.

Section 8. Municipal Councils Shall Fix Prices for Service to be Paid by Users.—The municipal council shall fix the prices a contracting corporation may charge public, private and other users for the service to be rendered by it to them, during a period of not less than five and not more than twenty-five years. The prices so fixed shall be computed on the basis of cost, and to produce sufficient annual income to fully pay all costs and to

yield the corporation its authorized share of profit.

Section 9. Municipalities Shall Receive One-half of all Surplus Profit.—In case a contracting corporation earns a surplus over its authorized share of profits such surplus shall be divided equally between the municipality and the contracting corporation.

Section 10. A Deficit Shall be Carried Forward.—In case a contracting corporation fails to earn its authorized share of profit, the full amount of the deficit shall be carried forward and included in the costs of the next following period for which the municipal government shall fix the prices that it may charge public, private and other users for the service to be rendered by it to them.

Section 11. A Lease of Municipal Rights of Way.—The contract shall include a lease to the contracting corporation for the purpose of rendering the service contracted for, of all municipal rights of way, and the right to enter upon all municipal public property, under such reasonable regulations as may be by ordinance established, so long as such a service is used by the municipality or by its inhabitants.

Section 12. Determination of Investment Value.—The determination of an investment value to be used as a basis for the computations provided for in this act shall be determined, originally, by an appraisement to be made by the municipal council, or by a joint arbitration entered into by mutual agreement between the municipal council and a corporation, or by a procedure in all respects identical with a procedure for the taking of private property for public use, as provided by law. Additions to the amount of investment value shall be made as they may become necessary in complying with the requirements of municipal ordinances.

Section 13. Power of Municipality in Case Contract is Refused.—In case a municipality is unable to secure for its use, and for the use of its inhabitants, a continuous supply of any public service by a contract drawn in accordance with the provisions of this act, with a public service corporation that is now, or may hereafter be rendering such service, or with a corporation that may be hereafter incorporated under the laws of this state for the

purpose of rendering such service, and only in such case, a municipality shall have the power, when authorized to do so by a majority vote of all electors voting on the question, when submitted to them by ordinance, at any regular or special election, to mortgage a lease of all municipal rights of way, and the right to enter upon all municipal public property, the property used as a means for supplying the service, and the entire income derived from such service, for the purpose of giving security for bonds it may issue to obtain funds for acquiring or constructing works for supplying the service, and it shall give no other security.

Section 14. Authorization for Consolidation.—In case two or more public service corporations engaged in supplying a public service to a municipality, or to any part of its inhabitants, shall desire to enter into a contract with a municipality in accordance with the terms of this act, they shall consolidate and form one corporation, without prejudice to any of their invested interests, upon such terms as shall be by them determined.

Section 15. Power to Lease Municipal Property.—Any village or city owning and operating the means of supplying any public service may, by ordinance, lease the same to be operated by a corporation, under a contract drawn in accordance with the provisions of this act.

Section 16. This act shall take effect and be in force from and after its passage.

The Utility Act known as Law of 1897 has not been enforced because it could not be.

It is unreasonable, unjust and unconstitutional and should be disregarded until it is repealed. No company affected by the law has been organized in the state since its passage.

Welsbach lamps have become so numerous in use, that the open jet is almost entirely supplanted. The efficiency of the lamps depends on the heating value of the gas without reference to the candle power.

This quality is also most desired in gas stoves and gas engine use. Where contracts are to be renewed or

changed in the future, it is well to secure a reduced candle power, because a high candle power is not needed and in many instances is a serious objection.

It is noticeable that an open jet flame is never displayed in a gas office close to a Welsbach light to solicit the use of gas with that burner. In fact it is hard to find a flat flame burner, which fact seems to indicate that a gas man is ashamed to show his light in that burner.

Welsbach lamps and mantles have become so cheap that they should be used exclusively.

The introduction of gas engines has been slow. Many people feel that their cost will soon be much less and they can wait for that time. They illustrate this point by mentioning sewing machines, bicycles and steam engines. The makers say they could reduce the cost if they could increase the sale largely.

Gas companies have to thank electric companies for their progressive business methods. They soon learned that the old way of doing business would not get or keep trade. Electric companies have also learned that flat rates do not always get profitable business and have changed their practice greatly in this regard.

It is a matter of regret that no incentive has been found to make water companies change their arbitrary rules and methods of doing business.

They are giving much attention to improving the quality of the water for which they are praised.

It is a matter of pride to us all to know that oil, coal and natural gas have advertised our state favorably. These are topics upon which three good papers should be written for our next meeting.

The list of papers prepared for our meeting is very gratifying and all have been written on short notice. To make the work of our successors pleasant, it seems desirable that we should at this meeting volunteer our services for the next meeting and the program is then easily arranged.

THE PRESIDENT:—Next in order is the selection of a place for holding the next annual meeting.

MR. BENDURE:—I will invite the Association to meet at Atchison, Kansas.

MR. PALMER:—I would be glad to have the Association meet with us at Leavenworth, Kansas.

Mr. Shaw invited the Association to meet at Topeka.

MR. PATMOR:—I believe that Pittsburg, Kansas, will be a good place to hold the next annual meeting and I invite the Association to meet there.

MR. STERRETT:—I move that the Executive Committee take into consideration the question of the place of meeting next year, and make a recommendation at some subsequent time during this meeting.

Carried.

MR. NICHOLSON:—I move that in view of the arduous duties of the Secretary that he be not required to pay any annual dues.

MR. FROST:—I amend the motion to add \$25.00 per year as salary.

Carried.

MR. FOLEY:—As there are a number of the members who must go home after this session, and as the subject of Mr. Nicholson's paper "On Needed Legislation" is of great importance, I move that this paper be the first one read.

Carried.

MR. SHAW:—I move that the Association go into executive session.

Defeated.

MR. FROST:—I move that the Association go into executive session, and that all Associate Members and Mr. Eugene Ware, of Topeka, be invited to attend.

Carried.

Mr. Nicholson's paper "On Needed Legislation" was then read. Discussion by Mr. Palmer, Mr. Morse, Mr. Bendure and Mr. Ware.

Adjourned.

December 13th—Morning Session.

Meeting called to order.

The following papers were read and discussed in the order named. See page 18 for papers:

"On the Softening of Public Water Supplies, with Some Analyses of a Recent Process," by Prof. E. H. S. Bailey.

"Some Points Concerning Water Supply," by Prof. F. O. Marvin.

"The Result of Experiments in the Use Iron Oxide for Purification of Gas Where Southern Kansas Coal is Carbonized," by Mr. L. T. Palmer.

"A Method of Protecting Underground Metal Structures from Electrolysis," by Prof. Lucien I. Blake.

"On Needed Legislation," by Mr. John C. Nicholson.

[NOTE:—The Secretary is very sorry not to be able to publish the papers, "On Needed Legislation," by Mr. Nicholson, and "A Method of Protecting Underground Metal Structures from Electrolysis," by Prof. Blake.]

THE PRESIDENT:—Is the committee on President's Address ready to report?

Mr. Palmer read the following report:

This committee has examined the able address of the President. We most heartily endorse the suggestions and recommendations made, and recommend the careful consideration of it by each member. Especially the points made regarding the plan laid out for the lowering of our taxes and the appointment of a Commission by the State similar to the Massachusetts Commission. Also that the address be made a part of the records of the meeting.

Respectfully submitted,

L. T. PALMER,
R. C. JOHNSTON.

MR. FROST:—I move that the report be received and the President's address be made a part of the record.

Carried.

THE PRESIDENT:—The Executive Committee has considered the question of the place and time of the meeting for next year, and recommend that November 13th be the

date and Leavenworth the place. All who favor this recommendation may signify by rising.

Carried.

THE PRESIDENT:—Is the Committee on Resolutions ready to report?

Mr. Frost read the following:

Resolved, That the hearty thanks of this Association be and is hereby extended to Professors Bailey, Blake and Marvin, and Mr. Nicholson and Mr. Palmer for the very able papers prepared for this meeting. Also to Mr. Eugene Ware for his good council and presence at the meeting.

Resolved, That the hearty thanks of this Association be extended to Mr. R. C. Johnston for his splendid entertainment of the Association and through him to the Merchants Athletic Association and the Commercial Club for the use of their rooms during the stay at Lawrence.

Respectfully submitted,

W. H. FROST, Chairman.

THE PRESIDENT:—What is your pleasure in regard to this report?

MR. PALMER:—I move that it be received and made a part of the record.

Carried.

The President then appointed all of the associate members as a committee to solicit for new members.

The following members volunteered to prepare papers for the next meeting:

Northrop Moore.....	Kansas City, Kan.
R. C. Johnston	Lawrence, Kan.
J. H. Foley	Leavenworth, Kan.
Atwood Cady	Fredonia, Kan.
Wm. Tracy	Salina, Kan.
W. H. Frost	Ft. Scott, Kan.
L. E. Riddle	Kansas City, Mo.
H. G. Seymour	Kansas City, Mo.
W. S. Gregg	Kansas City, Mo.
J. F. Schaefer	Kansas City, Mo.
R. S. Wakefield	Chicago, Ill.
T. M. Ambler	St. Louis, Mo.
H. S. Morgan	Topeka, Kan.
C. K. Sherman	Kansas City, Mo.

THE PRESIDENT:—A motion to adjourn is in order.

MR. JOHNSTON:—I move we adjourn.

Carried.

After dinner the members were taken in carriages to the Kansas State University, where they were shown through the Fowler Building, the Chemistry Building, the Electrical Building and the Gymnasium. From there they were driven over to the Haskell Indian Institute.

P A P E R S.

THE SOFTENING OF PUBLIC WATER SUPPLIES, WITH SOME ANALYSES OF A RECENT PROCESS.

BY E. H. S. BAILEY.

Professor of Chemistry, University of Kansas.

As water is softened and purified, on a large scale, for general domestic use, and as a boiler water, it becomes a matter of great importance that the process used should be first, thoroughly efficient, and second not too expensive. Softening and purifying are to some extent separate processes, but the same means used for softening does often purify in other ways. No reference is here made to the mechanical methods for sedimentation and filtration, both of which have a great deal to do with improvement of the water, but do not necessarily soften or purify it. When a chemical coagulant, as alum, is used, it is true that a large amount of the organic matter is also removed.

Still another method of purification might be suggested, namely, that of distillation, more efficient than any, but at the same time so expensive that it can only be used on comparatively small quantities of water, and where it is necessary to prepare fresh water from salt or brackish water. This, of course, destroys the pathogenic germs, and all the mineral matter is left behind; hence the desired result is completely accomplished.

The two softening processes generally used are, first, removal of the mineral salts by heat, as in the case of a feed water, and second, the removal of the salts, without heating, by the use of chemicals.

In order to understand the problems to be solved in softening water by the latter method, it is proper to discuss the substances which we wish to remove, that are present in water, and to consider which can be removed without too great expense. Our ordinary river, lake and ground

waters contain lime, magnesia, iron, alumina and soda, combined with such acid forming substances as chlorin, sulfuric anhydrid and carbon dioxid. These mineral substances are combined in various ways, dependent on their relative quantity and degree of concentration. Some idea can be gained as to what substances are present by a study of boiler scale, but this does not always tell the truth as to how the substances existed in the water, as concentration may change their combinations. In general, however, we may say that the following combinations may be present :

Calcium carbonate.....	Ca CO ₃
Magnesium carbonate.....	Mg CO ₃
Calcium sulfate.....	Ca SO ₄
Magnesium sulfate.....	Mg SO ₄
Sodium carbonate.....	Na ₂ CO ₃
Sodium chlorid.....	Na Cl
Sodium sulfate.....	Na ₂ SO ₄
Silica.....	S: O ₂

The other substances that are present are in such small quantities that their consideration is unnecessary.

The first four of these substances constitute most of the scale forming material, and are what give "hardness" to water, while the three sodium salts are extremely soluble and can not be removed except by distillation of the water. The chlorids of sodium, calcium and magnesium, if present, are corrosive in their action, and their presence in the water should be always considered on this account.

In the softening processes the following chemicals are used either singly or by combining several of them :

1. Calcium hydrate, or slacked lime.
2. Sodium carbonate, known as Sal Soda,
3. Sodium hydrate, known as Caustic Soda.
4. Sodium silicate, known as "Water Glass."
5. Some organic substance, as those containing Tannin, are sometimes used with the sodium compounds.

The material used in the process of softening should be selected from the known composition of the water to be purified. To bring this proposition within local lines, a consideration of some of our surface waters would be of interest: Let us look at the analysis of two of them that may be said to be typical of the extremes, namely, the Saline and the Delaware rivers, both streams belonging to the Kaw River drainage system. These analyses were made by Prof. E. C. Franklin and the author, and are published with others in the Kas. Univ. Quarterly, Vol. III. The results are expressed in parts per 100,000:

	Saline River.	Delaware River.
Silica and insoluble residue	2.44	1.31
Iron and aluminum oxids.	0.50	0.53
Calcium carbonate.	34.89	19.89
Magnesium carbonate.	16.34	7.43
Sodium chlorid.	113.30	3.86
Sodium sulfate.	62.16	2.96

On account of the presence of the large amount of sulfates in the Saline water here is an opportunity for calcium sulfate, as well as other incrusting salts, to be formed in a boiler. As the amount of sodium chlorid is large here, this, also, will act very injuriously on the boiler. The Saline River has, then, the constituents that would make it "permanently hard."

If the water is of the character of the Delaware, the "Lime process" may be used with success, as it will remove most of the incrusting salts, in the absence of sulfates. In this process the excess of carbon di-oxid, or carbonic acid as it is generally called, unites with the lime added, and the whole is thrown down, thus—

If there is an excess of lime some more magnesium may be precipitated as hydrate, but this is somewhat sol-

uble, so some of the magnesia is liable to remain in the water.

The same final results may be brought about with the carbonates of lime and magnesia, if, instead of lime, we use caustic soda, thus:

The sulfates can be removed by the use of sodium carbonate, but not by the use of lime alone, thus—

Instead of using the caustic soda we may use the sodium carbonate with lime and have the caustic soda formed in the solution, and the work done just as effectively, thus:—

or in the presence of magnesia,

The whole problem, as stated by F. A. Dochray in a recent article, is easily solved. If carbonates of lime or magnesia are present, use lime to remove them; if sulfates are present, use caustic soda or sodium carbonate, or more economically, use these or either of them with lime. This double treatment will remove the carbonates and sulfates, and completely soften the water. Lime is cheap, while sodium carbonate or caustic soda is expensive. So we do not use the latter unless the water demands it, as it costs at least six times as much.

It is of interest to note some of the best practice with

these processes and the result: A recent paper from the International Railway Congress (Paris, 1900) on the "Purification of Feed-water of Locomotives," gives the data required:—

On the Southern Railway of France the following results are obtained—in the case of a water free from sulfates:

	Before treatment.	After treatment.
Calcium carbonate.....	17.5	4.5

Of magnesium carbonate, calcium sulfate and magnesium sulfate only traces were present.

The process as used at El Paso, Texas, on the line of the Southern Pacific R. R., is a good illustration of treatment in case both the sulfates and carbonates of lime and magnesia are present. Results are stated in grains per gallon:—

	Not treated.	Treated.
Calcium carbonate.....	11.62	1.08
Calcium sulfate.....	9.86	0.42
Magnesium carbonate.....	1.68	2.72
Magnesium sulfate.....	5.24	1.02
Magnesium chlorid.....	0.90	None
Silica	1.74	1.90
Iron and aluminum oxids.....	0.13	0.27
Alkali sulfates.....	None	14.67
Alkali chlorids.....	23.07	23.07
Scaling salts.....	31.17	7.42

The cost of this process as stated is two and one-half cents per 1,000 gallons. Lime and soda ash are the chemicals used.

A plant was installed at the works of the Edison Electric Illuminating Co., Topeka, Kansas, in the spring of 1899, for the use of the Tweedale process of softening water. Through the courtesy of C. R. Maunsel, superintendent, we have had an opportunity of inspecting the plant and taking samples of water for analysis. The chemical analyses were made under my direction by Henrietta Henderson, an advanced student.

In regard to the process I quote from Mr. Tweedale's description. "The apparatus consists of three wooden tanks, each of 10,000 gallons capacity, with one reducer and oxidizer to each tank. This consists of a closed cylinder, inside of and concentric with which is placed another cylinder leaving a space of one-half inch in the sides, two inches at the bottom and one inch at the top. This inside cylinder has a perforated top and bottom, and is filled with sheet iron coiled spirally. It has spaces $\frac{3}{4}$ of an inch between the contiguous spirals; these spaces are filled with coke. The interior space of coke and exterior spiral of iron are connected by a strip of copper forming a galvanic battery. There is also an air pump for agitating the water with compressed air, also the necessary system of pipes for filling the reservoirs with water, also pipes for drawing off the water, purified, and the sludge whenever its accumulation renders its removal necessary. The treatment is as follows: Put into one of the tanks the quantity of alkaline reagent (standardized hydrate of soda) required, as has been previously ascertained, and also one pound of ferric chloride, then fill the tank with water which passes through the supply-pipe, aerator, reducer and oxidizer, thence through the pipes with curved ends into the tanks, and at the same time air is forced into the water."

The apparatus is said to actually handle 50,000 gallons every 24 hours instead of the 20,000 contracted for, and the water is very satisfactory for boiler use.

The object of the chemical analyses was three-fold: First, to find out how thoroughly the apparatus softened the water; second, to ascertain what action, if any, was due to the coke and iron in the "oxidizer," and third, to see what effect the process had on the organic matter in the water.

No. 1. Original city water.

No. 2. Water treated without oxidizer for half an hour only.

No. 3. Water treated without oxidizer for two hours.

No. 4. Water treated with oxidizer after two hours.

These samples were secured on February 13, 1900.

The results of the analysis, which are represented in parts per 100,000 parts of water, are as follows:—

	No. 1.	No. 2.	No. 3.	No. 4.
Silica and insol. matter...	2.07	2.10	1.94	2.77
Iron and aluminum oxids	0.26	0.49	0.63	0.37
Calcium oxid.....	14.83	5.15	4.73	3.41
Magnesium oxid.....	3.60	2.99	2.64	3.95
Sulfuric anhydrid.....	2.39	2.09	2.30	2.74
Chlorin.....	12.81	13.11	12.58	13.84

There is present also sodium in some combination, and an excess of carbonic anhydride.

It is not possible to tell how these substances are combined in the water, even if the composition of the scale produced was known, but in general, according to established custom, after evaporation they would be combined as follows:—

	No. 1.	No. 2.	No. 3.	No. 4.
Silica and insol. matter.	2.07	2.10	1.94	2.77
Iron and aluminum oxids	0.26	0.49	0.63	0.37
Calcium carbonate.....	23.50	9.20	8.44	6.09
Calcium sulfate.....	4.06			
Magnesium carbonate....	7.56	6.28	5.54	8.30
Sodium carbonate.....	2.78	13.33	6.88	7.09
Sodium chlorid	21.11	21.60	20.73	22.80
Sodium sulfate.....	trace	3.71	4.08	4.86

By a study of this table it is seen:

First: The process removes from the water 60 per cent of the lime and magnesia.

Second: Taking the lime and magnesia together, there is just as much removed from the water by the process without the "oxidizer" as with it. This would seem to indicate that the coke and iron had no effect in soften-

ing the water, though the aeration, by the compressed air, which is used in both cases, has no doubt an excellent effect.

Third: The amount of alkali salts (that is, carbonate, sulfate and chlorid of sodium together) in the purified water is raised about 50 per cent, and this increase is in the sodium carbonate and sulfate, both substances that cause the water to have an "alkaline" character.

Fourth: While the process softens the water satisfactorily, and removes the calcium and magnesium sulfates that are present, as well as a large per cent of the carbonates, yet with a water of this character, where the *quantity of sulfates is small*, a lime softening process would do the work about as effectively, and at a less expense, as far as the cost of materials is concerned. The addition of the iron chlorid may assist in the rapid coagulation and settling of the material. It is, of course, possible that there might be some mechanical difficulties, so that the sludge would not settle as rapidly if lime only be used.

A series of analyses was also made on the water before and after softening to see what effect the process had on the amount of organic matter present. The results are as follows, expressed in parts per 100,000—

	Original water.	Water after softening.
Free ammonia.....	0.035	0.025
Albuminoid ammonia....	0.145	0.112
Nitrogen as nitrates.....	0.010	0.014
Chlorin	8.366	9.063
<hr/>		<hr/>
Total residue..	64.000	80.600

These results show a decrease in the organic matter, and show that the mineral salts, carry down, when precipitated, some of this material, and thus improve the water.

As an instance of what can be done by the use of the two substances, lime and sodium carbonate, the plant used

by the Tiffvale Railway Co., in England, illustrates the subject in a practical way. The water is passed through two tanks and is there mixed with the two reagents named. It is afterwards allowed to stand and precipitate the carbonate of lime. The water used contained $\frac{12}{13}$ grains of calcium carbonate per gallon, and 8 grains of sulfates. About 70 per cent of the lime is removed, and the water is said to be soft and fit for domestic use. The cost is less than two cents per 1,000 gallons.

SOME POINTS CONCERNING WATER SUPPLY.

BY FRANK O. MARVIN, M. Am. Soc. C. E.
University of Kansas.

It is taken for granted that the gentlemen who very largely make up the membership of this association are directly interested in the selling of as large amounts as possible of the products which, in a sense, are the results of their manufacture. In the lines of gas and electric light production, or the furnishing of a water supply, the same economic laws obtain as hold good in other lines of industrial production or distribution. To bring ample returns and a satisfactory service, the article offered must be of good quality, be manufactured at a minimum cost consistent with the maintenance of a quality standard, and be sold to the largest number of consumers possible at a low but fair margin of profit.

Because a water supply is so closely related to individual and public health, its purity and freedom from contamination become prime essentials. If a water is not safe for any reason, whether taken from an impure source or one liable to objectionable pollution, or rendered objectionable in any way during the transmission to the consumer, it is not wanted at all—the market is dead.

Hence, those of your number that are connected with water supply plants have imposed upon them a necessity for a constant vigilance, both because it is a duty due to

their customers and because it is a wise, long headed financial policy. It is not enough to find and use a good, wholesome source of supply; it must be also maintained as such, and the water drawn from it kept in a good and wholesome condition for the consumer's use. Water men often have serious difficulty in maintaining satisfactory conditions, even when the water at its source is without fault. Topeka, for instance, though using a satisfactory ground water, filtered by Nature's own processes, has had some trouble with a minute vegetable organism, called *crenotherix*, that has developed in the well and mains with astonishing rapidity during late summer, and which, on dying and decaying, has given an odor and taste to the water.

Lawrence, also using a safe and wholesome ground water, has considerable trouble with a minute low form of animal life, belonging to the *polyzoa*, which clogs its mains and requires frequent flushing during the summer months to keep it from imparting objectionable odors and tastes to the water. So far as the writer knows, neither of these organisms are directly detrimental to health; but they do affect the sale of water through making it offensive to the consumer. Just how to permanently get rid of either of these objectionable organisms is as yet an unsolved problem.

In some water supplies, where the water is collected from the surface and stored in ponds or large basins, trouble is sometimes had through the rapid development of some species of algae in such numbers that the dead plants give fishy tastes and odors to the water. I have so far known of no such trouble in Kansas. Kansas supplies seem to be drawn from three sources: Artesian wells, which should furnish a good water, provided that it be not too much impregnated with mineral salts. Ground or sheet water, which should, generally speaking, be a safe water if the pumping plant be wisely located; not always the case. But this class of water calls forth peculiar problems; how to get rid of iron or other objectionable

mineral matter and how to prevent the growth of low forms of life that seem to thrive in such waters.

The third source is surface water as it runs in our streams or is collected from water-sheds. This class is more liable to direct pollution with the matters that set up disease in the human system than either of the others. Yet there are many Kansas localities that can secure a public supply in no other way. As a country becomes more and more thickly settled and its population more and more concentrated into cities and towns, these will be driven more and more to the use of surface waters as furnishing the only supplies adequate in quantity. Then we are face to face with the problem of how to deal with a polluted water, how to make it safe for domestic use. England and other thickly-settled portions of the old world have been working at this problem for many years. Some of our Eastern and Central states are working at the proper solution for their own conditions and the time is not far off when Kansas and other Western communities will have to attack the problem.

The whole sanitary movement is of recent development, for very little of the scientific knowledge on which it is based was known twenty-five years ago. As to water supplies and water treatment we have learned more in the last fifteen years than all the other years of the century. At the same time it must be admitted that there is much yet to learn, especially in adapting the principles already gained to varying local conditions.

A very brief review of results obtained and a statement of the trend of recent investigation may be profitable here.

The primary object of all efforts is to render the water safe for human use; that is, to free it from all disease germs, from conditions that favor their growth, and to maintain it in such state. These efforts have taken two directions, viz: the prevention of the pollution of water by sewage and the treatment of the water itself.

The early thought underlying sewage treatment was

chiefly a selfish one. Men saw valuable matter; the natural food of plant life, going to waste and endeavored to recover this and return it to the soil and thereby put money into their own pockets through the sale of fertilizers made in the application of their processes. England has granted about 500 patents to ambitious inventors, most of whom were actuated by this idea of gain—suffice it to say that every process based on this has proven a failure. The principle that endures in all matters relating to sewage treatment calls for the best and purest results in the effluent, which must be harmless or as free from noxious elements as possible. If anything is saved, somewhat as a by-product, it is a secondary matter. Chemical treatment through precipitation has failed to furnish an effluent of organic purity, though it may prevent a sewage polluted stream from being a nuisance. Land irrigation, either broad or intermittent, is of limited application and often expensive to the point of prohibition. Slow sand filtration was successfully practiced in Europe for many years, but it remained for the Massachusetts State Board of Health, about ten years ago, through its engineers and experts at the Lawrence Experiment Station, to demonstrate the scientific working of the process and to show the limits of its application. Their work proved that the action is a bacterial one, and that it is possible to so purify raw sewage that the effluent is a safe and wholesome drinking water, so modified in its chemical composition that its elements are stable and practically containing no germs; even the bacteria, through the agency of which the organic matter is changed to inorganic forms, disappearing in some way not yet fully understood.

This investigation, still being carried on, has also shown that the process is applicable to the purification of a contaminated water, and its introduction at various places in this country has resulted in a marked reduction of the number of cases of water borne diseases, notably typhoid fever, formerly so prevalent.

While in this country we have been investigating this

process of slow sand filtration of sewage, which calls into action the class of *aerobic* bacteria, those which require oxygen for the carrying on of their life processes. English experts and investigators have been stimulated into new lines of action and have developed a new process that is being studied both there and in this country and which promises good results at less cost than any other so far brought forward, viz; the so-called "septic tank." In this, another class of bacteria, the *anaerobic* or those not requiring oxygen, are brought into action. The sewage is discharged at the outfall into an underground masonry tank, air and light tight, where the *anaerobic* bacteria attack and break up the organic solids, so that the organic matter appears in the effluent in solution, rendering it free from solids and yet foul. This effluent is then turned intermittantly on to sand filters, where the *aerobic* bacteria attack the organic matter held in solution, change it to inorganic forms, doing their work and then dying themselves, and finally rendering the effluent nearly pure. In the septic tank proper there is only a slight accumulation of inorganic matter in the shape of a sediment at the bottom and a thick coating of scum which floats on the surface and which seems to maintain a constant thickness and take care of itself. The advantage of this process lies in a more rapid rate of treatment than by any other and a consequent reduction in the first cost of plant and the annual charge for maintenance, without any sacrifice as to the quality of the effluent.

While successful sewage treatment undoubtedly prevents stream pollution by the sewage treated, it does not by any means solve all of the water problems presented at different places. Sewage from cities and towns constitutes only one of the polluting agencies. And in many locations it may be a wiser economy to limit sewage treatment to the securing of an effluent only partially purified, to the extent of the prevention of a nuisance, and to getting a more complete and perfect treatment of the water supply. In England and on the continent much more

attention has been given to water treatment than has to this time obtained in this country. But the high death rates in our cities from typhoid and other diseases whose germs are carried by water are forcing attention to the matter and many of our cities are making independent investigations of their own conditions.

At first, the successful results obtained in Massachusetts seemed to indicate that slow sand filtration furnished the way out, but when the process was applied to the waters of the central or western states, unexpected difficulties were met with. The waters of the New England states, coming from granite and sandstone hills, carry comparatively little silt and fine sediment. On the other hand the waters of the middle west, coming from regions covered with limestone and clay deposits, are largely charged with silt and this has been found to seriously interfere with the process of slow filtration. Solution of the trouble has been sought in the so-called "American System" of rapid filtration, or "mechanical filtration," as it is sometimes designated.

Louisville, Cincinnati and Pittsburgh have carried on extensive investigations with experimental plants from which much has been learned. In a general way the results have proved that mechanical filtration with the use of a coagulant, sulphate of alumina or crude alum, when combined with previous subsidence, will produce a satisfactory effluent, the process rendering the water clear and free from silt, and removing 96 to 99.5% of the bacteria in the applied water, all of the organic matter in suspension and nearly all held in solution and at a rate of 120 to 170 million gallons per acre per day, or about 100 times faster than by the slow English method of sand filtration.

At Cincinnati the average cost for chemical used amounted to about \$3.20 per million gallons at the current price of $1\frac{1}{10}$ cents per pound, and using an average amount of $1\frac{9}{10}$ grains per gallon. The amount used was too small to affect the water in any harmful way for domestic use,

though it slightly increased its hardness and would tend to increase the amount of boiler scale. This latter is, however, considered to be more than offset by the removal of the solids carried in the raw, untreated water of the river. This process wherever used will demand a good quality of supervision and high grade of maintenance if it is to yield good results.

Another point brought out by these investigations is that each water to be treated must be studied for itself. That the details that are applicable at one point are not necessarily so at another. Indeed this is so whatever method may be used. Each water has its own characteristics and these must be known and methods adapted to them before the best results can be obtained.

It seems to the writer that Kansas water men should be constantly on the quest for information concerning the article which they offer for sale and favor any movement that will add to the sum of their knowledge. So he is led to suggest to the Association a Kansas water survey, possibly through the medium of the University Geological Survey, or possibly through the State Board of Health. Something has been done through chemical analyses of some Kansas waters, by the chemists of the University and other institutions, and something from a sanitary standpoint through the Board of Health. But this has been of a fragmentary nature. What is suggested would demand a systematic investigation from the standpoints of geology, biology and chemistry, and a study of present conditions. The data gathered would certainly be helpful to all concerned with public water supplies and would tend to better the service and happily influence public health while increasing the earning capacity of the water plants. The state could well afford a modest expenditure in this direction.

The writer would refer those interested in the latest results of recent investigations on rapid filtration to the following:

"Water Purification at Louisville," by Geo. W. Fuller, New York, 1898. \$10.00.

"Report on Water Purification," by Geo. W. Fuller, Cincinnati, Ohio, 1899. Published by the city.

"Report of Filtration Commission," Pittsburg, Pa., 1899. Published by the city.

"Experimental Filter Plant at Pittsburgh," by Morris Knowles.

In November, 1900, number of Journal of the Association of Engineering Societies.

*THE RESULT OF EXPERIMENTS IN THE USE OF IRON
OXIDE FOR GAS PURIFICATION WHERE SOUTHERN
KANSAS COAL IS CARBONIZED.*

BY L. T. PALMER.

It has been long considered impossible to use oxide for the purification of gas, in this country where coal from southern Kansas is carbonized. The writer had a proposition made him several months ago which made it possible to experiment with the iron oxide (which is a mineral) from Richmond, Va., at a reasonable figure, the company guaranteeing satisfactory results or no pay. I ordered 20 tons which was shipped in sacks, each containing about 300 pounds. This iron oxide resembles very fine sand, only is purple in color, and absorbs a large amount of water, which is necessary in preparing it for the boxes, the same as lime. It is much heavier than lime to handle, but shovels like wet sand, hence is more pleasant to handle. In my first experiment, I used it clear, but found in my boxes which are only 10x10 feet, that to put in sufficient to purify 150,000 cubic feet of gas per day, it caused a back pressure so I mixed about one-fourth to one-third shavings with it and this combination works to at least eighteen inches thick without any evidence of back pressure. The season was so late and our output so large and our purifying capacity so limited, that, to date, I have not tried to use it to the entire exclusion of lime, but

used it only on lower trays with a five or six inch layer of lime on top trays. In this manner I have purified perfectly, so far as our tests will show, 150,000 feet per day, but we were troubled with bisulphuret of carbon to such an extent that I have postponed further experiments with it until after the holiday season, when I shall again take up our experiments and am very confident of success with its use, thereby making a great saving in cost of purification, as the company claims that each bushel will purify 350,000 cubic feet of gas before being exhausted. This being the case, the cost per thousand for purification would be \$0.001 $\frac{1}{2}$, while lime costs us at Leavenworth, to purify per thousand cubic feet, about \$0.03, so one can see at a glance, the great saving by the use of the oxide.

In our experiments, the oxide was left in contact about four days and when opened up, it presented much the appearance of spent lime, only not caked, but very black. We wheeled it out into the open yard and dumped about eight to ten inches thick and as soon as chemical action took place, it commenced to heat; we then stirred it over every day and in three or four days, it had returned to its former or purple color and after another wetting down, was ready for use again. The first time it is used it does not seem to take up the sulphur so much and does not become blackened as in the subsequent usings; in fact, I am inclined to think it has to absorb quite an amount of sulphur before it is at its best, for the longer I used it, the better my results. Another item of saving is when it has taken up all the sulphur it is capable of absorbing, it is then marketable to acid factories, thus getting back quite a large proportion of the original cost. I would have no hesitancy in recommending its exclusive use in this territory where southern Kansas coal is used, to any who had ample capacity for purifying, and I have confidence that after a few more experiments with it, we shall be able to use it at Leavenworth, almost if not quite to the exclusion of lime. Our capacity is now taxed to the utmost with clear lime.

Its original cost is about \$10.00 per ton or \$0.50 per bushel delivered to Missouri river points, the freight being much the greater portion of the expense. The other sponges in use in the east or where Pennsylvania Coal is used, is much lighter in weight, hence will not purify to exceed 200,000 cubic feet per bushel which weighs about thirty pounds and is largely made of shavings.

The manufacturers are glad to furnish a sufficient quantity for a trial—satisfaction guaranteed or no pay. In this stage of the business where the price of gas is being cut down to the minimum point, Superintendents and Managers have to cut all the corners possible in order to pay out interests and dividends and in no other part of the Manufacturers's department can a greater percentage of saving be made than in the purifying rooms.

[NOTE:—This paper was read at the Second Annual Meeting, at Kansas City, Kansas, Nov. 15-16, 1899.]

DOMESTIC AND PUBLIC WATER SUPPLIES.

BY WYNKOOP KIERSTED.

The importance of the recurrent discussions of the leading questions relating to municipal affairs is universally admitted. But however interesting and important may be the general discussion of such topics in national conventions, there is frequently as great interest and even more profit in similar discussions in the district and state organizations, where there is opportunity for a more detailed exchange of experience upon matters of common interest. In this connection the question of public water supplies occupies, doubtless, as prominent a place as does any other question of general interest. But the various phases of even this question seem almost unlimited, because it embraces not only matters pertaining to the gratification of a natural want, but also those associated with the health and the industrial pursuits of all communities. In its relation to health it is necessarily of paramount importance. And in this direction alone the

development of the past few years attracts widespread attention and has received an extensive amount of scientific study. While dependence upon the public water supply becomes more and more absolute as cities thrive and the density of the population increases, still the individual is often loath to part with his cistern or his well in exchange for the tap water, believing the latter to be more unwholesome. This belief may be based upon either fact or fancy, depending whether the private or the public water supply receives the greater care to insure wholesomeness. The effort of recent years has been directed to the improvement of the public water supply with a view of rendering it irreproachable from a sanitary point of view and of convincing the individual of its superiority.

No one will venture to question the purity of rain water, *per se*. There is no doubt but that rain water uncontaminated on its way to the cistern and then properly protected from pollution while in storage, is perfectly safe for dietetic purposes. But the fact is often disregarded that between the raindrops and the cistern and between the cistern and its enclosure there are many dangers of contamination which may not become apparent until they accumulate sufficiently to offend the senses. The first roof washing after each interval of drought discolors the rain water and carries into the cistern the roof accumulations of dust and dirt. From this conglomeration the highly solvent rain water abstracts mineral and organic impurities and allows the insoluble matter to deposit on the bottom of the cistern as a black and filthy mud. This debris is doubtless no worse than that carried occasionally by a flowing stream but the lesser dilution in the cistern than in the stream and the continued accumulations in the cistern under conditions which at times promote putrefactive changes of the organic matter, assures a greater and an increasing pollution.

The best attention practicable to bestow upon the collection of rain water cannot prevent altogether the entrance of foul matter from the roof. Even the combina-

tion of filter and cistern may not arrest all the suspended matter, and unless the filter be carefully watched, cleansed and aerated it will in itself become a source of serious pollution.

The presence of vaults and cesspools upon the premises is usually considered a menace to the wholesomeness of cistern water. A little reflection, however, will convince one that this fear or suspicion is groundless in the majority of cases. It is customary to locate the cistern as near the house as possible and the cesspool or vault in some remote corner of the premises. If there were any underground communication between a cistern and a vault, then the direction of discharge would depend upon the relative level of the water in the cistern and the bottom of the vault. But in natural earth, water moves slowly by percolation along the line of least resistance which is invariably downward and in the general direction of the natural slope of the ground. Excavations through and beneath a vault, particularly in heavy soil, disclose in soil discoloration the steep slope of the lines of precolation descending cone-like from the bottom of the vault within such restricted limits as to scarcely intercept a cistern were it only ten feet away. In fact, under ordinary conditions the danger of contamination of a cistern from a vault is, to say the least remote, and from the street sewer is scarcely possible.

Too much significance, therefore, should not be attached to the chlorine found in cistern water as evidence of sewage pollution. Its most probable source, aside from the roof washings, is the slops carelessly thrown from the kitchen and the refuse tracked from the barn-yard or stable which seep at every rain into the cistern through an imperfect covering or the joints of the enclosure. In one of the writer's examinations a cistern was found to contain a large amount of chlorine, which he traced directly to the salt water waste from an ice cream freezer, which it was customary to use upon a conveniently broad wooden platform covering the cistern.

While the cistern is exposed to evident but almost uncontrollable contamination from the surface, still the private well is liable to an undetected contamination by percolation from the cesspool or vault as well as to pollution from foul surface drainage. This is particularly true of public water supplies drawn from shallow wells located near a populous district upon the same general slope of ground. The almost continuous pumping from such wells is found to perceptibly affect the level of the ground water over a wide area and to drain private wells in the vicinity. The clear, cool and palatable water drawn therefrom agreeably affects the senses, and consequently may escape suspicion of any contained pollution.

The deep well furnishes a water which has its source at some remote water shed and which has undergone a long and slow process of natural filtration. It is practically free from recent organic pollution and may be perfectly wholesome although often containing free ammonia in such a quantity as would lead to rejection if found in shallow well water. But on the one hand, it is the rare exception that the private well penetrates the deep water bearing strata, and on the other hand deep wells are only occasionally desirable for a public water supply, because of the uncertainty of supply in large amount, and the usual presence of heavy mineral impregnation and the great expense of construction and maintenance.

Notwithstanding the fact that western river waters can be made palatable and safe for domestic use, still there is often an aversion to accept water for this purpose which is unsightly in its natural condition and of which the history is more or less intimately known. However the knowledge is being rapidly diffused and generally accepted that the senses are not infallible guides to a correct judgment of the wholesomeness of a water for domestic use, that a knowledge of the history of a water is a safeguard to health in that it suggests the treatment the water should receive before use or makes possible detection of

the sources of pollution and the application of measures of relief, and that vastly the greater percentage of the detritus in our river water is wholly free from any contaminating effect upon the water and can be successfully removed at a reasonable expense.

The danger of sewage seriously polluting the large rivers is still quite remote because of the enormous dilution which it receives, and also because of the natural purifying agencies constantly at work in flowing water. Sewage disposal upon land or sewage purification where it is practicable, will greatly aid to preserve the purity of the smaller streams and rivers. But when it is impracticable to wholly eliminate offensive and dangerous pollution of this character, the filter skillfully constructed and managed, constitutes one of the surest safeguards to health which has yet been devised in connection with the purification of public water supplies. This view we are compelled to accept in the light of over a half a century's experience with filters in European countries where the records show the filter to have practically sterilized a water known to have been infected or seriously polluted, and in the light of more recent experience in this country.

Whenever the problem of water purification is largely one of clarification, the settling basin in its fullest development is reliable. That is to say, it can be made to so far remove the turbidity of the natural water as to be almost if not wholly undiscernable in a porcelain lined bath tub. Such results may be unusual or even impracticable as settling basins are ordinarily operated, for they depend as much or even more upon the management of the basin as upon its capacity and general design. They require more than merely natural settlement during a brief period of comparative rest. This simple process of settlement permits the removal of a large portion of the sediment, but leaves a fine and light remnant which imparts to the water an objectionable turbidity. In this condition the water can be more completely clarified by additional settlement with the aid of a coagulant.

Through this combined process of natural settlement followed by coagulation and additional settlement in a compartment sedimentation basin, a water of unusual clearness may be obtained with surprising rapidity.

No unwholesomeness follows the judicious use of a coagulant, although the hardness and the amount of carbonic acid in the original water may be slightly increased.

Solutions of Sulphate of Alumina (Alum) or of iron are the coagulants generally accepted. The use of the former is practically restricted to a water which contains carbonate of lime, or in the absence of this quality, to one which has received a treatment of lime water. The use of iron requires the presence in the natural water of free oxygen or an alkaline base to unite chemically with the salt of iron. The Alum is probably the more desirable coagulant as it is more readily prepared in solution and introduced in the process of treatment. So long as the water remains alkaline, that is to say contains lime and similar minerals as a carbonate or oxide there is no danger of undecomposed alum remaining in the treated water.

The Missouri River at this point has sufficient alkalinity for the greater part of the year to decompose from thirteen to eighteen grains of the commercial sulphate of alumina per gallon of water. As a rule one-half to one grain of alum per gallon of water is sufficient for the purpose of clarification. In the spring of the year the difference between the alum decomposing capacity of the Missouri River water and the amount of alum required for clarification is less than at other seasons of the year, because the spring freshets reduce the alkalinity of the river water and at the same time increase the amount of fine and light sediment to be disposed of. However, with the proper precautions to observe daily at this critical period the alum decomposing capacity of the water, there is no risk of introducing an excess of the coagulant, and the work of clarification may be conducted successfully

without endangering the wholesomeness of the water for domestic purposes.

During the spring and summer months the Missouri River water contains from seven to eighteen or more cubic yards of sediment in each one million gallons. Of this amount a variable but large percentage, depending upon the character of the sediment, will deposit naturally. The remnant coagulates readily with an alum solution varying in strength with the amount of fine sediment to be removed. Because of the rapid variation of the amount and character of the sediment carried by the river and of the variableness of the alkalinity and the corresponding change in the strength of the alum solution, systematic observations and analyses are for a time desirable in order to accustom the attendant of the basins to vary the strength or the amount of the coagulant solution to suit the varying conditions of the river water.

The method of clarification herein advocated is not advanced as a theory. It has been found experimentally to be feasible. The writer since 1893 designed numerous sedimentation basins which in operation involve the use of a coagulant. Among them are the sedimentation basins of the water works of Kansas City, which have recently been remodeled to clarify the water of the Missouri River by the combined process of natural settlement and coagulation. The result is that a clear and wholesome water is now furnished this city even when the river is excessively muddy.

The expense of equipping a settling basin with coagulating apparatus and with arrangements for conducting systematic observations of the character of the water to be treated and of the water after treatment, is not great. It will afford ample return upon the investment where dependence rests upon sedimentation to clarify a water which is impure largely because of suspended matter.

In conclusion we are led to believe that greater care and more systematic methods than it is customary in

many instances to bestow upon the purification of the public water supply, will do more towards securing the confidence of the public and towards the voluntary discarding of the cistern and private well, than will volumes of literature or the most persuasive arguments, or the most restrictive rules of a health department.

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